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ABSTRACT

The literature on adult, vocational, and distance education was reviewed to identify areas needing research in order to guide decisions on the use of distance delivery in adult vocational education in Minnesota. Literature on participation in and barriers to participation in adult education was reviewed as was literature on the clientele served by adult vocational education, changes in the workplace that have impinged on vocational education, and the currency of vocational education. The review of literature on distance education focused on works dealing with the following topics: factors affecting learning, effects of distance delivery on teaching and teachers, conditions encouraging the use of distance delivery, barriers to the use of technology, and effectiveness of distance delivery. The following were determined to be areas in which further research is needed: effect of interaction of learning tasks, learners, and modes of distance delivery on learning outcomes; teaching behaviors that enhance student learning in a distance delivery context; barriers to adults' participation in vocational education that might be overcome by the use of distance delivery; conditions and outcomes that justify the cost of distance delivery; and characteristics of technologies used in education. A three-page reference list concludes the document. (MN)

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Adult Education and Vocational Education: Implications for Research on Distance Delivery

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Adult Education and Vocational Education: Implications for Research on Distance Delivery

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ABSTRACT

The purposes of this report are to review aspects of adult education, vocational education, and distance delivery and to suggest research which needs to be done to guide decisions on the use of distance delivery in vocational education for adults in Minnesota. The main question which organizes this report is, "What knowledge is needed to determine whether distance delivery can be used to provide high quality vocational education for adults?" Five areas of research are suggested: effect of interaction of learning tasks, learners, and modes of distance delivery on learning outcomes; teaching behaviors that enhance student learning in a distance delivery context; barriers to adults' participation in vocational education that might be overcome by the use of distance delivery; conditions and outcomes that justify the cost of distance delivery; and characteristics of technologies used in education.

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INTRODUCTION

This paper presents a review of aspects of adult education, vocational education, and distance delivery. Topics related to the use of new technologies to improve the delivery of vocational education are suggested for study. The paper is intended to point out knowledge which is needed to answer the question, "Can distance delivery be used to provide high quality vocational education to adults in Minnesota and, if so, how?"

Sources for the paper included reviews of literature, reports of studies, papers reflecting both present status and future directions, and interviews with experts. Because of the size of the literature in adult education and vocational education, secondary literature in these areas was used extensively with some references to primary literature. Not only has there been relatively little research done on distance delivery, the technologies themselves are changing so rapidly that the literature is not keeping up. The paucity of pertinent literature on distance delivery resulted in considerable reliance on interviews (referred to in the paper as personal communications) with practitioners and leaders in their respective fields.

In this paper the term "distance delivery" refers to providing instruction to learners who are at remote sites. Either a technological device (such as a computer) or an instructor using some medium (such as a television) provides instruction. A discussion of this and related terms appears in the section on distance delivery.

ADULT EDUCATION

Adult education consists of sustained, deliberate, independent efforts to learn on the part of adults (Tough, 1971) and courses and other educational activities organized by teachers or agencies (National Center for Education Statistics as cited in Cross, 1981) enabling adults to acquire knowledge or skills. Themes in adult education literature included in this section are participation, barriers to learning, adults' goals in learning, and preferred ways of learning. These themes develop a context in which distance delivery will be discussed in a later section.

Much of adult education research is descriptive in nature and little is explanatory. There is also little theory in adult education (Mezirow, 1971) to guide research or practice, although there are some models (Boshier, 1973; Cross, 1981, chaps. 5 and 9; Miller, 1967; Rubenson, 1977; and Tough, 1979) emerging to explain aspects of adult education.

Participation

Participation is one of the most frequently researched topics in adult education (Rockhill, 1982) and findings tend to fall into two categories: extent of participation and demographic variables associated with participation. Estimates of adult participation in adult education range from less than 10% to virtually all adults (Cross, 1981, chap. 3). If enrollment for credit or certification is equated with adult education, very few participate in it, and if deliberate, sustained effort is the criterion for inclusion, adult education is nearly universal. Between these extremes, if "organized learning" or "receipt of instruction" is the definition, estimates of participation rates range from 12% to 30% of the adult population (Cross, 1981, chap. 3). Interpreting

findings about participation is further complicated by treating it as a dichotomous variable (Rockhill, 1982). In reality, involvement in adult education tends to be relative, with more active involvement at varying times over the lifespan. Most studies report that more adults express interest in participating than actually participate (Rockhill, 1982).

Studies describing who participates in adult education usually report demographic variables, and the demographic profiles are consistent across studies for adults participating in organized learning activities (Cross, 1981, chap. 3). However, the demographic variables account for only 10% of the variance associated with participation (Anderson and Darkenwald, 1979).

One of the most consistent findings in participation studies is that "a great disparity exists in the involvement in continuing education of segments of the population situated at different levels of the social hierarchy" (Johnstone and Rivera, 1965, p. 231). Amount of education is the demographic variable having the greatest influence on interest and participation in organized learning activities; the more education people have, the more interest they have in further education (Cross, 1981, chap. 3). Cross suggests that lack of interest in education is the initial barrier to participation among less educated adults. Those who are substantially under-represented in adult education are the elderly, black persons, persons who have not graduated from high school, and persons with annual incomes under $10,000 (Cross, 1981, chap. 3).

Barriers to Participation

In addition to the studies on who participates in adult education, there has been research done on why adults do not participate in educational activities. Most of the barriers to participation can be divided into four categories:

situational, institutional, informational, and dispositional. Situational barriers that arise from one's life context include time limitations, location of residence, and costs of education. Cross (1981) notes that these barriers can be exaggerated by adults since they tend to give socially acceptable responses to questions about participation. Institutional barriers consist of all those policies and procedures that exclude or discourage adults' participation in educational activities. Length of the educational program, class schedule, and strict attendance requirements are common institutional barriers. Informational barriers refer to the failure of institutions to communicate information on learning opportunities to adults and the failure of adults to seek or use the available information. Dispositional barriers relate to values and attitudes about oneself as a learner. They include concerns about age, ability to learn, and energy.

What Adults Learn

The literature is quite clear about the pragmatic nature of adult learners. Most who initiate a learning project on their own do so to solve a problem or because of their responsibilities, rather than to learn about a topic for intrinsic reasons (Cross, 1981, chap. 8). Penland (cited in Cross, 1981, chap. 8) found that nearly three-fourths of a representative group of adults who described their learning projects told about "practical topics" such as home repairs, job skills, homemaking, and driving. Coolican (cited in Cross, 1981, chap. 8) concluded in a review of studies that the most popular learning projects dealt with vocational subjects, home and family, and hobbies and recreation, in that order.

Data regarding adult participation in organized learning activities, such as

courses, suggest similar patterns. From most to least popular, subject matter categories include: occupational training; general education; social life and recreation; personal life and family living; and community issues (National Center for Educational Statistics cited in Cross, 1981). Vocational topics are preferred over other topics by a wide margin. When asked why they are learning, the majority of adults indicate that their reason is to get a new or better job or to advance in their present one (Cross, 1981, chap. 1). However, the demand for occupational education might be exaggerated by the present population bulge in the early career stages (Arbeiter, 1979).

Hoare (1982) suggests that in the future, vocational education programs for adults will revolve around job realignment needs, knowledge and skill upgrading, and identification of new areas of work. Some adults will need vocational training several times. On the other hand, Hoare cautions against using functional competency as the only rationale for adult education, because there is a trend towards structural unemployment. The economy will not provide jobs for all adults who want them, regardless of their training or experience.

VOCATIONAL EDUCATION FOR ADULTS

Aspects of vocational education which are relevant to the issue of delivering high quality vocational programs to adults are discussed in the following paragraphs. Included are projected clientele to be served, changes in the work force influencing vocational education, and currency of vocational education. In this paper no distinction is being made between post-secondary and adult vocational education.

Clientele Served by Vocational Education

Changing demographic characteristics of the nation are presently affecting and will continue to affect the clientele vocational education serves. The number of young adults in Minnesota (Swanson, 1984) and the nation (Future Influences, 1984) will continue to decline until the early 1990's, and the proportion of older adults will continue to increase. Young adults of minority backgrounds will constitute a larger portion of the population, and by the end of the decade nearly half of the labor force will be women (Future Influences, 1984).

Recruitment of students in all post-secondary schools will become more competitive as the number of students traditionally served by them declines. In addition to traditional students, there will be an increasing number of women, older adults, disadvantaged persons, persons who have special needs, minority group members, and individuals for whom English is a second language (Gappa, 1981; Greenwood, 1982) in post-secondary schools. The tendency for secondary schools to require students to take more math, science, and language classes will limit their opportunities to take vocational courses which will cause individuals to seek more occupational training at post-secondary vocational schools

(Future Influences, 1984).

The predicted changes in the clientele served have implications for access to vocational education. Equitable access to vocational education is a major challenge for the field (Gappa, 1981; Lewis, 1979). Enrollment patterns of men and women (Gappa, 1981; Golladay, 1981) and of minorities (Golladay, 1981) indicate that these populations are concentrated in certain vocational education programs and are not distributed across fields. In her review of papers addressing equity issues in vocational education, Gappa (1981) pointed out barriers to access for nontraditional students. Barriers inhibiting students' efforts to enroll in vocational education can be characterized as socially induced, institutional, and individual. Social barriers to succeeding in vocational education programs include students not having requisite skills or financial support and programs being designed for persons with middle class values. Some vocational education personnel are unfamiliar with the needs of minority students or are unwilling to serve them in appropriate ways. In spite of problems surrounding equity, Gappa suggests that there has been a positive attitude change about equity, and legislation has mandated equal opportunity for vocational education for all Americans and special programs for those traditionally under-served. Serving the needs of nontraditional students will cause changes in services offered, such as flexible scheduling.

Institutional barriers refer to difficulties schools have in providing programming. Lewis (1979) identifies availability of programs (in the geographic sense) as one of the most pressing challenges for vocational education. The cost of providing programs in sparsely populated areas is prohibitive in some cases, and as some job skills become more specialized and change more

rapidly, it will be even more difficult to provide vocational training in some communities. The potential for using distance delivery to overcome these barriers is discussed in the section on distance delivery.

Individual barriers arise out of learners' individual life situations. There is growing recognition that post-secondary vocational education clientele must be served in more diverse ways to accommodate their needs and resources (Dede, 1982; Gappa, 1981; Herschbach, 1984). For example, employed persons, persons with physical disabilities, and parents of small children may require flexible programming to meet their needs. New communication technologies offer possibilities of delivering highly specialized training in more diverse settings, such as community and employment sites and homes (Dede, 1982; Harris-Bowlsbey, 1982; Herschbach, 1984), thereby minimizing constraints on adults' learning. Wisconsin is presently delivering seven vocational courses using its educational television network, cable television, and instructional television fixed-service, and reaching new audiences as a result.

Changes in the Work Place Impinging on Vocational Education

Economic conditions in the nation and Minnesota are clouded by the national budget deficit and the sluggish economy. Reduced exports and the increase of some imports contribute to the economic problems of the nation and create less stability in employment. The rate of productivity growth in the U.S. lags behind much of the industrialized world. In the early 1970's, the increase in the GNP per employee was only 8% in the US and was 38% in Japan (O'Toole, Brousseau, and Ralston, 1979).

Changes in world demand for American products and rapidly changing technology will result in workers needing skills upgraded to remain in their jobs

and in more displaced workers who will need retraining for different jobs--perhaps 3 or 4 times during their work lives (Future Influences, 1984). For example, not only is there a shift from manufacturing to high technology jobs for which training is needed, but also jobs in manufacturing require workers to learn new skills to use more advanced technology. Large scale changes in the work force are needed to increase the productivity of "knowledge workers" and to improve the skills of their supervisors (Nickols, 1983).

Technological innovations in telecommunications, computers, and robotics will require both shifts in employment and upgrading of worker skills. As many as 100,000 workers might be displaced by robots by the end of the decade (Future Influences, 1984). But influencing a much larger portion of the work force will be human-machine partnerships (Dede, 1982). The machines will do the routine functions, and the workers will do the more complex cognitive functions, such as evaluating, synthesizing, and making decisions based on incomplete information. Most jobs requiring little skill will be eliminated; although, as Dede points out, there will be some exceptions in the service industries.

Predictions regarding new jobs differ. One point of view holds that the major source of job openings in the near future will be the replacement of workers, not new jobs (Future Influences, 1984). Swanson (1984) on the other hand, points out that job creation in the nation has been vigorous since 1960, superseding that of other countries and is likely to continue. Service industries, especially information services, are projected to continue replacing employment in manufacturing (Dede, 1982). The trend towards more small businesses suggests the need for vocational students to receive training in business, although the high rate of failure of small business should be noted

(D. Passmore, personal communication, June 11, 1985). Vocational educators are challenged to detect trends in new jobs quickly and accurately in order to provide timely training.

Currentness of Vocational Education

Lewis (1979) includes the currency of curriculum, staff, and equipment in vocational education programs among the most pressing challenges for the field. Questions regarding the use of distance delivery to improve the potential of vocational education to respond to these challenges arise. Can curriculum updates be facilitated by communication technologies? Is it feasible to provide in-service education for instructors via distance delivery? Can the use of new technologies provide simulated experiences with state of the art equipment?

Changes in the work place (Greenwood, 1982; Nickols, 1983) and changing technology (Future Influences, 1984) converge to increase the criticalness of curriculum updates. With the accelerating rate of change, the currentness of the technical aspects of vocational education is likely to become even more critical than at present. Sorenson (personal communication, June 10, 1985) notes that rapid program expansion in areas such as laser technology, flexible manufacturing, and international trade must occur quickly at the same time that other occupational programs should be discontinued. More emphasis on verbal skills and computational skills in vocational curricula seems inevitable (Gappa, 1981) because of demands for more highly skilled workers and because more persons for whom English is a second language are entering vocational schools.

Closely related to curriculum updating is personnel updating. Today's older teaching cadre is in its middle to late career stage. Finding ways to keep instructors, administrators, supervisors, and guidance counselors

(Harris-Bowlsbey, 1982; Lewis, 1979) current in their respective fields is particularly important. Swanson (personal communication, April 3, 1985) suggests that vocational educators should be the source of state-of-the-art job practices. Ongoing occupational experiences in their respective fields might be provided for instructors (S. Grossbach, personal communication, January 4, 1984; B. Sorenson, personal communication, June 10, 1985), and the possibilities of simulations and demonstrations via distance delivery might be explored as ways to help instructors to keep pace with technological advances.

It has also been suggested that an increased use of distance delivery will change teaching so that instructors will be managing learning rather than disseminating information (Future Influences, 1984). If this is true, instructors will need in-service education to learn how to develop and deliver training materials using distance delivery (Harris-Bowlsbey, 1982).

Counseling adults regarding vocational programs has implications for the use of new technology. Currently, there is an unsatisfactory ratio of counselors to students, and adults seeking training more frequently will increase the strain on counseling services. Computer-based guidance and information systems have the potential to ease the demand. Such guidance systems are said to be effective because they are appealing to the user, are objective, handle massive amounts of data, and accommodate many users simultaneously (Harris-Bowlsbey, 1982).

Having practical experience on up-to-date equipment in vocational education is necessary to train competent workers, but it is becoming more difficult for vocational programs to afford the equipment. Communication technologies offer the potential for simulating technical laboratories and field trips at nominal

costs (Dede, 1982). Such experiences would not otherwise be available to learners because of cost, safety, or physical location (Herschbach, 1984, chap. 5). Obsolescence of curriculum and instructors might be off-set by the use of distance delivery.

DISTANCE DELIVERY

Discussed in this section are factors affecting learning, effects of distance delivery on teaching and teachers, conditions encouraging the use of distance delivery, barriers to the use of distance delivery, and the effectiveness of distance delivery. First, a clarification of two key terms is presented.

Terms related to distance delivery are varied and used inconsistently in the literature and by practitioners. Definitions of terms vary as well. The conventional use of the term "educational technology" referred to the media or devices used by instructors in their teaching (Herschbach, 1984). Examples included projectors, blackboards, flip charts, etc. More recently, the meaning of the term has been broadened to refer to the systematic design, implementation, and management of the instructional process which includes and goes far beyond technological devices.

"Distance delivery" refers to instruction being provided while the instructor and learners are at different locations. Two significant dimensions emerge in sorting out these and other terms and meanings (C. Dede, personal communication, June 4, 1985). One dimension focuses on learners receiving instruction at a site convenient for them. When learners are at sites removed from the instructor, technological devices such as telephones and satellites can be used in the instructional process. The other dimension focuses on whether a technological device is providing the instruction or is delivering the images and sounds of a person who is providing the instruction. A computer is an example of a device which provides instruction to the learner; in contrast, an instructor's voice and image can be conveyed to the learner by television.

For the purposes of this paper, the term "distance delivery" refers to providing instruction, either by a technological device or an instructor via some medium to learners who are at remote sites. Distance delivery is used in the context of educational technology--the systematic design, implementation, and management of the instructional process. "Technologies used in education" refers to mechanical and electronic devices applied in instructional processes.

Factors Affecting Learning

Research has provided a great deal of information about the learning process and the factors that influence learning (Lipson, 1984). Now that the new technologies are beginning to be used in education, what will their effect be on learning? There are four factors regarding the use of technology for instructional purposes that warrant examination: mode of delivery, content, message, and the learner. Each of these contains a number of variables which influence the effectiveness of an educational program (Bates, 1980).

Mode of delivery. Mode of delivery refers to the technology used to transmit that which is to be learned. There are unique differences among the ways knowledge can be presented: it can be in audio form, video form, or both; and it can be live or recorded (Hooper, 1982). The mode of delivery determines some of the parameters of the content that can be presented and learners' access to it. Each technology has its unique strengths, such as television reaching a large audience and computers permitting students to control their own learning pace (Solomon, 1976).

According to Bates (1980), selection of media tends to be determined by questions of access, the target audience, and available resources. Some media, such as radio or television, would provide access to most learners in a

geographic area--in contrast to computer-based delivery which would be targeted to a more specific audience and would have limited penetration. The influence of the quality of production on the effectiveness of courses broadcast via television continues to be debated (Bates, 1980), even after considerable research on the topic. Using dramatic light and sound effects, elaborate sets, and make-up on instructional television is a controversial issue. Many practitioners think of interactive instructional television as an extension of the classroom, so that preparation for teaching and presentations of lessons need not be very different from conventional classes. Others argue that each technology should be exploited more fully to find better ways of teaching, and therefore, more elaborate production is necessary. Little evidence exists regarding the effect on learning of the quality of production in media other than television and film.

Content. The next set of factors which can influence the efficacy of technology in instruction relates to content or knowledge to be conveyed. Soloman (1967) argues that one medium may be better suited to a particular kind of content, while another may be better for other content. For example, microcomputers might be appropriate to teach higher-order thinking skills, like advanced math, whereas the interactive videodisc is better suited to teaching complex psychomotor skills like engine repair and surgery (Dede, 1982). However, Schramm (1977) argues that learning materials can be adequately transmitted through any medium with equal effectiveness. Lipson (1984) states that most of today's didactic instruction can be taught via distance delivery as well as it is taught in the conventional classroom. While these authors do not reference research on effectiveness in their arguments, results of studies indicate

generally that there is little or no difference in learner outcomes when various media are compared (Herschbach, 1985, chap. 5). Issues regarding effectiveness are reviewed in later sections.

Message. A symbol system is used to encode a message so it can be communicated (Soloman, 1976). The symbolic system is the factor most specifically linked to media and is considered more important than the influence of mode of delivery or content to be conveyed (Bates, 1980). Content, such as facts or concepts, and presentation style, such as stories and metaphors, are not media-dependent for transfer of meaning. But symbol systems are associated with particular media. The greater the variability for a symbol system, the more levels of meaning it can potentially carry. For example, television can present a very wide range of symbol systems such as written and spoken language, numbers, and music (Bates, 1980). In order to increase learning when using technological devices, it is important to understand the unique differences among these aspects of media.

Learners. The learners and their learning environments also influence the choice of technology that might be used. As indicated earlier, adult learners are motivated to learn by their specific needs. Because media provide a variety of symbol systems, individual learning styles might be supported by different combinations of technologies in educational programs. Cross (1981) not only suggests that learners have different learning styles, but that they also differ in their experience with media and ability to learn from media. Data from the 1970's indicated that although adults considered television to be an important learning resource, few appeared to have used it while trying to learn on their own.

Effects of Distance Delivery on Teaching and Teachers

The effects of technology on education is less than was expected a few years ago. The introduction of microcomputers, videodiscs, instructional television fixed-service, and other innovations heightened expectations in the educational community. Herschbach (1984, chap. 3) states that the use of new technology is much less than has been predicted, and that technology cannot meet the demands for cost reductions, increases in the productivity, and quality of instruction placed on it. The potential of the newer technologies in education far exceeds the ability of the field to use it. According to Herschbach, a primary reason for the gap between potential and actual use is the high cost of the technology, which will be discussed in a later section on barriers and the use of technology. Related to cost is the low usage of technologies which schools have already acquired. Scheduling problems, limited number of users, lack of software, and maintenance problems contribute to equipment being used infrequently, which in turn makes equipment expensive on the basis of per student or per hour usage. The situation in vocational education is exacerbated by its student population being split out into several areas of study. Instructional materials are typically related to only one occupational cluster, and they become outdated quickly.

Few teacher preparation programs provide systematic, in-depth study of the applications of technologies in education. Education of both pre-service and in-service teachers needs to be expanded to include the use of new technologies (Office of Technology Assessment, 1982, chap. 1) if more benefit from them is to be realized. Educators who can create innovative, functional, effective software for the technologies now in use are in short supply (Herschbach, 1984,

chap. 4). Increasing the use of these new devices seems highly dependent on the production of software. (In this paper, software refers to materials developed for use with computer, video, and audio technologies, such as computer programs and videotapes).

As indicated earlier, the role of teachers may change from disseminating information in conventional classrooms to one of management of instruction, with much of the instruction being done by technological devices. Harris-Bowlsbey (1982) suggests that in the past, effective instructors were interested in working face to face with students and in using personal communication skills. Rewards in teaching, and perhaps even the motivations for entering teaching, might change if there are substantial changes in role. Herschbach (1982, chap. 5) suggests that increasing the use of technologies might result in deprofessionalizing teaching as the emphasis on management of learning and technological devices increases. Although experience with computer-assisted learning has indicated that computers have not caused a reduction in the number of teaching jobs, some educators continue to voice concern about a possible decline in the number of jobs for teachers resulting from an increased use of technology.

Because of the high cost and labor-intensive nature of software development, production of software tends to be centralized and distributed to large segments of the educational community. This results in the centralization of curriculum to some extent, which in turn results in standardization of instruction. Under some conditions, such as training employees in different plants or offices to complete tasks in the same way, standardization of instruction would be highly desirable. However, the uniqueness of learners, teachers, and local job

characteristics might not be accommodated entirely satisfactorily by materials developed centrally.

One other characteristic of media that should be noted is the passive or interactive mode of the learner when engaged with the technology (Office of Technology Assessment, 1982, chap 5). Instructional television, for example, is a passive instructional system where all of the educational decisions are under the control of the medium and the presentation of content is the primary goal. The learner cannot adjust the pace, ask questions, or control the stimuli. In contrast, interactive instructional systems, such as computer-assisted learning, present information and allow the learner to control aspects of learning by communicating with the system. This approach is more adaptive to the learners' needs and can individualize instruction more than passive systems.

Conditions Encouraging the Use of Distance Delivery

The potential of new technologies to deliver education to learners in more satisfactory ways is, perhaps, the most compelling reason for its adoption. Distance delivery is well suited to providing general education to a dispersed population and specialized education to small populations (Office of Technology Assessment, 1982, chap. 5). Some aspects of vocational education can be considered general to a sizable vocational education population, although occupational content is highly specialized. There is an expanding adult population which desires more education, but faces time constraints resulting from employment and other responsibilities (Cross, 1981, chap. 1). Conventional ways of serving their needs is not entirely adequate. Distance delivery can ease the demands of time and travel for learners and might eliminate the threat of classroom participation for some adults (Office of Technology Assessment, 1982,

chap. 5). The number of adults served is projected to increase with wide scale use of distance delivery (Office of Technology Assessment, 1982, chap. 5; Miller, 1982; Harris-Bowlsbey, 1982).

The new technologies offer new and possibly better ways to deliver some content to learners. Simulations and other learning activities too costly or dangerous for learners to experience first hand can be accomplished using appropriate technology (Office of Technology Assessment, 1982, chap. 5). For example, some of the newest processes in fiber optics are impossible to teach in parts of the country where the indicated equipment and materials are not available, but a "videotaped field trip" can provide opportunities for students to become aware of current innovations. Distance delivery might encourage the use of different formats for offering vocational education; formats such as training packages that might be sold or leased to companies without linking the materials to student enrollment (B. Sorenson, personal communication, June 10, 1985). This might enhance the efficiency and relevance of the training. Other ways in which technologies might influence the quality of education is by providing instructors an opportunity to work with experts to produce software and by observing master teachers (Hale, personal communication, May 1, 1985).

Some sources (C. Dede, personal communication, June 4, 1985; Harris-Bowlsbey, 1982; Herschbach, 1984, chap. 5; Office of Technology Assessment, 1982, chap. 5) indicate that technologies can increase the productivity of teachers. Adding a few students to television classes or teleconferences increases the cost of instruction little or none. So the emergence of new technologies might make it possible for vocational education to maintain or improve the quality of education at the same time that there are demands for increased

productivity and declining fiscal resources for education. However, this view is not held by all. The issue of cost-effectiveness is discussed in a later section in this paper.

The new technologies also offer the possibility of improving aspects of education. Lipson (1984) emphasizes the importance of procedural learning in vocational education and the potential of new technologies to provide it. "Sophisticated computer simulations, especially when combined with visual support from a videodisc, allow more trials, more systematic development, and more exploration of the consequences of various options than either on-the-job training or training using actual equipment" (p. 7). The new technologies also make it possible to individualize learning by allowing the student to control the pace, time, repetition, etc. of learning activities, as can be done with computer-assisted instruction and video tapes. Delivery of vocational education via television has had a very positive response from learners in Wisconsin (B. Sorenson, personal communication, June 10, 1985).

It is suggested in a report by the Office of Technology Assessment (1982, chap. 5) that technology might be used to compensate for the lack of qualified staff. In occupational fields that are emerging or changing rapidly, technology might be used to amplify the instruction of the few well-qualified teachers. Where there are sparsely populated areas, instructors might include in their classes learners in remote sites via telecommunications.

The last factor encouraging the use of distance delivery to be noted here is the increasing power and sophistication of the technologies. Artificial intelligence (C. Dede, personal communication, June 4, 1985) might significantly improve the quality of vocational education if it can be harnessed. And the

linking of telephone, computer, and video technologies opens enormous potential for improving instruction (Herschbach, chap. 5 and Office of Technology Assessment, 1982, chap. 5). Costs continue to decline at the same time as the friendliness and power of technologies are increasing (Forman, 1981).

Barriers to the Use of Technology

The barriers inhibiting the implementation of distance delivery can be classified in the following general categories: financial, availability of hardware and software, technical and theoretical information, and acceptance of the technology.

Financial barriers. Financial barriers are among the problems mentioned most frequently in the literature and by practitioners and include the cost of hardware, software, maintenance (particularly of the more advanced electronic equipment), and to some extent staff development. The initial investment in hardware is high, inhibiting institutions' introduction of new technologies; but Hooper (1982) suggests that in the future the cost of computers will be so low that they will be available in most schools and homes.

Of hundreds of citations on the effectiveness of computer-assisted learning in educational literature, only six report cost data in any form (Lewis, Dalgaard, and Boyer, 1984); the paucity of cost data is typical of the literature for all technologies used in education. Lewis et al. (1984) identify three conditions under which computer-assisted learning (as well as other technologies) can be cost-effective: computer-assisted learning costs the same as conventional instruction but results in higher achievement in the same amount of instructional time; it results in students achieving at the same level but in less time; or, it results in an increase in student-teacher ratios, with

achievement at the same level as conventional teaching. These authors point out that in instances where costs of using technologies in education are calculated, they are usually understated because the value of factors, such as faculty time and cost of equipment usage, is ignored.

Herschbach (1984) argues strongly that new technologies are add-on expenses and will not, in most cases, lower the cost of providing educational services. He states that the new technologies probably will not replace teachers, but will supplement their efforts, as has been the pattern with other technologies. As currently used, the technologies will not reduce educational costs or increase teacher productivity. Low usage compounds the cost barrier. Computers, interactive instructional television, and other devices are used relatively few hours of the day, week, or month. Either the number of learners or the amount of time learners use the technologies must be increased substantially to approach cost-effectiveness. There are other more immediate and less capital-intensive ways of reducing costs, no matter how inexpensive the technology being used (Kincaid, McEachron, and McKinney, 1974). For example, using paraprofessional staff where possible or increasing student-teacher ratios will reduce costs more quickly and with less risk. The arguments of proponents and critics suggest the need for careful examination of cost-effectiveness of the new technologies.

Hardware and software. Availability of high quality software is the most pressing challenge in using the new technologies in education (C. Dede, personal communication, June 4, 1985; Herschbach, 1984, chap. 6; Miller, 1982; Office of Technology Assessment, 1982, chap. 1). Underlying this problem is a lack of knowledge of what elements in software will promote various kinds of learning.

Software development is costly and time-consuming, and there are few educators skilled in designing it. Presently, educators and students are not rewarded for using distance delivery (C. Dede, personal communication, June 4, 1985). Until incentives for implementing the technologies are sufficient, little change is likely to occur. Miller (1982) points out that the movement of corporations to implement their own in-house education programs depends, in part, on how quickly vocational education develops software (and the attendant instructional systems) that will be tailored to the needs of learners. If vocational education does not fill the gap, she suggests that the private sector will.

Having sufficient hardware in locations where learners have access to it is problematic and is, of course, partly a financial problem. Computer hardware and software compatibility continues to be a significant barrier. Selecting hardware is difficult because of the many choices of systems to be used in delivering education, the diversity of equipment, and the rapid changes in technology.

Technical and theoretical knowledge. A lack of technical and theoretical knowledge is a barrier to the implementation of technologies in education. Not only is there a lack of knowledge about developing software to promote learning, as indicated above, but many instructors do not understand how to use the new technologies. Further, little is known about integrating these new ways of learning into an overall plan. The more powerful technologies, such as artificial intelligence in computers, might promote learning of higher-order cognitive skills that are difficult to assess with today's evaluation procedures and, therefore, the resulting pedagogical gains may be under-valued (C. Dede, personal communication, June 4, 1985). The inappropriate use of technologies can

affect both the institution and learner negatively (Office of Technical Assessment, 1982).

Acceptance of technologies. The last barrier to be highlighted in this section is acceptance of new technologies. There is a natural tendency for organizations to resist change. Misconceptions about the use of technology limit innovation and threaten teachers' job security and status (Zuber-Skerritt, 1984). Instructors are not inclined to use technologies that require substantially more preparation time, and it is difficult to provide instructors and learners access to technologies that are easy to use (Herschbach, 1984, chap. 5). Some policies, such as funding, inhibit the application of technology. For example, institutions and teachers typically receive more financial rewards for teaching students "on campus" than at a distance (C. Dede, personal communication, June 4, 1985).

Effectiveness of Distance Delivery

Herschbach (1982, chap. 2) states that although there is considerable literature regarding the use of technology in education, it should be interpreted with caution. Much of the literature about the effectiveness of media lacks rigor and specificity.

Generally, it appears that one mode of distance delivery is not substantively superior to others or to conventional teaching methods (Clark, 1983; Herschbach, 1984, chap. 4; Office of Technology Assessment, 1982, chap. 5). Neither are the new technologies judged to be poorer in learner outcomes. Clark (1983) states that the current evidence suggests that media are vehicles which deliver instruction but do not influence student achievement. Rather, the methods being employed by the media influence learning.

Computer-assisted learning (CAL) lends itself to distance delivery, but to date it has been used primarily in teacher-lead classrooms or laboratories which extend traditional classroom instruction. Because of its potential use in distance delivery, discussion of CAL is included here. Studies at the elementary school level consistently indicate CAL can improve achievement scores; but, studies focusing on secondary and college levels result in less clear findings regarding achievement scores (Lewis, Dalgaard, and Boyer, 1984). Several studies of computer-assisted learning with elementary, secondary, and college students indicate computerized instruction shortens the time required to learn material and results in positive attitudes towards learning (Kulik, Kulik, and Cohen, 1980 and Hall, 1982). However, some evidence (Herschbach, 1984, chap. 6) indicates that adults who used the PLATO computer instructional system had neutral attitudes towards learning and had higher course withdrawal rates than adults in traditional classes. The research data indicate that computer-assisted learning results in learner outcomes similar to those of other instructional methods.

Most of the research done on visual media has been done on instructional television and films. The extensive research done indicates there are no significant differences in learner outcomes when comparing these media and conventional teaching methods (Herschbach, 1984, chap. 6). Much of the research on instructional television has been done with pre-school and elementary school learners.

Little research seems to have been done on audio technologies used alone. Audio conferencing via telephone has been used extensively in Wisconsin for post-secondary education and has been evaluated as being similar to conventional

classes in learner outcomes. Schramm (1977) concludes that combining audio tapes with print materials can be very effective. Audio technology can be particularly helpful to both sight-impaired and il-literate learners. Very little research has been done regarding the effectiveness of other media, such as interactive videodisc, interactive educational television, and videotext.

The following conclusions might be drawn: there are no substantive differences in achievement or cost-effectiveness among the technologies and conventional methods of teaching; the technologies are not being used appropriately so no differences emerge; or there are differences, but the research has not detected them. Perhaps the first conclusion is premature and should not be embraced yet, since the period of experimentation and adoption has been relatively short for the educational community. If, over time, no differences are found, educators will have to decide whether "no differences" is a basis for adopting or rejecting the use of technologies.

The second conclusion, that the devices are not being used appropriately, bears more consideration. Dede (personal communication, June 4, 1985) points out that effective use of technologies requires a reconceptualization of instruction. Conventional ways of teaching, such as lecturing, will not fully utilize the potential of the technologies. More development work is needed in order to exploit the unique capabilities of the various technologies.

The research on technologies in education completed thus far has not been as fruitful as educators might like. Much of the research has focused on the medium rather than instruction or learning. For the most part, the research questions have been gross comparisons of the efficacy of different technologies and conventional classrooms. Herschbach (1984, chap. 4) suggests that research

should focus on the interaction between the instructional design, learning task, and learner. Such research might result in more useful explanations of why different media might be better suited for a specific learning task. If more were known about the unique qualities of different technologies, educators could design learning strategies using a mix of methods of teaching and technologies that would more effectively promote learning. The greatest benefits from technologies in education are thought by some (Office of Technology Assessment, 1982, chap. 5; Miller, 1982; Herschbach, 1984, chap. 4) to be in combining different technologies and in combining them with conventional teaching.

SUMMARY AND RECOMMENDATIONS FOR RESEARCH

Depending on the definition of adult education, between ten percent and virtually all adults engage in adult education each year. The more years of formal education completed, the more likely an adult is to participate in organized adult education programs. Those who are under-represented in adult education programs are the elderly, minorities, poor, and persons who have not completed high school. Time, cost, location of residence, institutional policies, information about adult education, and attitudes about one's self as a learner are barriers that inhibit participation. Adults are pragmatic about learning and have specific learning goals in mind if they engage in formal courses. Vocational education is the kind of education adults participate in most frequently either to get a job or to improve present job skills.

The number of traditional students to be served in vocational education is projected to continue declining, but it is likely that more minority students, more women, more persons with special needs, and more older adults will continue to enter vocational education programs. Job requirements will be changing so rapidly that more workers will be retooling more frequently. Retraining the work force increases the demand on vocational education. The rapidity with which jobs are changing presents a major challenge to vocational education to keep instructors, curriculum, and equipment current.

Distance delivery might increase the capacity of vocational education to serve the needs of adults for job training. The new technologies could enable instructors to improve instruction and to teach learners who face constraints which prevent their participation in vocational training. While there has been some integration of the new technologies into instruction, the gap between

potential and actual usage is very great. Instruction and learning have not changed appreciably. Barriers inhibiting the use of new technologies in education include their cost, availability of software, and acceptance of technologies and skill in using the technologies. Research on the efficacy of distance delivery generally indicates that as it's presently used, it is no better or worse than conventional classroom teaching. However, the research has been somewhat restrictive regarding the questions that have been studied, the technology that has been investigated, and the populations that have been studied.

Recommendations for Research

What knowledge is needed to determine whether, and how, distance delivery might be used to provide high-quality vocational education for adults in Minnesota? Below are four research areas that could provide needed information to answer that question.

> How do learning tasks, learners, and technologies interact to affect learning outcomes? As stated, this is a broad area of research requiring a series of studies, and it is a complex phenomenon to study. Software could be improved if there were a better understanding of the interaction of properties of technologies (such as interactive and passive characteristics) with factors such as complexities of tasks; cognitive, affective, and psychomotor skills; and various types of content. If the adult learners in vocational education are becoming more diverse, as is predicted, more needs to be known about the interaction between distance delivery and learning styles, learning skills, learning tasks, and motivations for learning. Because most of the technologies can individualize learning, research should focus on how individuals learn, rather than how groups learn. Inroads in this area seem necessary to effect more precise conclusions than "no significant differences" among media and to enable practitioners to apply the technology.
>
> What teaching behaviors enhance student learning when technology is used either to deliver the teacher's voice and visual image (such as interactive instructional television) or when a device (such as a computer)

delivers part of the instruction? For example, when using interactive television, what teaching materials enhance learning? How might teachers interact with learners in remote locations? How does interactive television affect the time learners spend on learning tasks? When combining conventional teaching and computer-assisted instruction, what teaching behaviors encourage adult learners to complete courses and what behaviors help learners integrate knowledge learned in different modes? Knowing what behaviors support learning when using distance delivery would give direction for pre-service and in-service education of instructors. At present, vocational instructors of adults have little more than experience in conventional classrooms and intuition to rely on as they try new ways of teaching.

Which barriers faced by adult learners can be overcome by the use of distance delivery? To date, there is little evidence that new technologies alleviate time, travel, informational, institutional, and personal constraints faced by adult learners, although the claim seems logical. It is not clear what impact delivering education at work sites and homes might have on education, work, and family. As technologies are integrated into educational programs, participation of both traditional and previously under-served populations should be studied.

Under what conditions and for what kinds of outcomes does the use of various technologies justify their costs? This research should not simply compare costs and learning outcomes of technologies and conventional teaching. Focusing on these comparisons encourages the use of standard learner outcomes rather than seeking improved conditions for learning complex knowledge and skills. A frame of reference is needed to indicate when conventional teaching, distance delivery, or both conventional teaching and distance delivery is preferred or acceptable. The cost of technologies is among the pressing practical problems facing vocational education and is the dominant factor for some of those who are deciding whether to implement new technologies for delivery of vocational training.

A final suggestion regarding research needs in the area of distance delivery in vocational education emanated from an advisory group which discussed issues related to this paper. (See the Appendix for the list of persons participating

in advisory groups). Leaders in vocational education in Minnesota would benefit from a macro-level survey of technologies used in education. Technologies used in distance delivery, such as computer-assisted learning, teleconference, and interactive television would form one dimension of a matrix. Characteristics of technologies such as the following would form the second dimension: individual/group learning, passive/active nature of learner response, hardware availability, cost of software and hardware, ancillary costs, learning style, and flexibility of delivery modes. The categories along both dimensions should be extensive if not exhaustive. Where categories intersect and the contents of the cells are known, the knowledge could be indicated. For example, in the cell where "computer-assisted learning" and "individual/group learning" intersect, the capacity of the computer to individualize learning would be explicated. Data from research literature, elementary and secondary schools in Minnesota, and experts would be sources of information for developing the matrix. Cells in the matrix about which little is known, but are thought to be important in the planning and implementation of technologies in vocational education, would provide a focus for more research.

All decisions regarding the use of distance delivery for vocational education for adults in Minnesota cannot and should not wait until the research suggested above is completed. However, limited knowledge about the potential of the technologies encourages unrealistic expectations, waste of resources, and poor practice. There is a sense of urgency regarding knowledge about the use distance delivery.

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Appendix

The following persons were interviewed during the development of this paper, and many were quoted in the paper.

Dave Bunting, Kirkwood Community College, Iowa
George Copa, Department of Vocational and Technical Education, University of Minnesota, Minnesota
Christopher Dede, University of Houston, Texas
Marilyn Flack, Austin Community College, Minnesota
Sharon Grossbach, State Board of Vocational Technical Education, Minnesota
Rodney Hale, South County Washington Schools, Minnesota
Mavis Monson, Instructional Communications Systems, University of Wisconsin, Wisconsin
David Passmore, Division of Occupational and Vocational Studies, University of Pennsylvania, Pennsylvania
Marilyn Rossmann, Department of Vocational and Technical Education, University of Minnesota, Minnesota
Bob Sorenson, State Director of Vocational Education, Wisconsin
Gordon Swanson, Department of Vocational and Technical Education, University of Minnesota, Minnesota
Robert Tennyson, Department of Educational Policy and Administration, University of Minnesota, Minnesota
Gordon Williams, Special School District 916, Minnesota

The persons listed below attended advisory meetings where research on the use of distance delivery in vocational education for adults was discussed.

Deena Allen, State Board of Vocational Education, Minnesota
Jay Dean, State Board of Vocational Technical Education, Minnesota
George Halonen, Hutchinson Vocational Technical Institute, Minnesota
Helen Henrie, State Board of Vocational Technical Education, Minnesota
Bill Ledo, Hennepin Technical Center, Minnesota
John Mercer, State Council for Vocational & Technical Education, Minnesota
Herb Murphy, Anoka Vocational and Technical Institute, Minnesota
Dave Pucel, Department of Vocational and Technical Education, University of Minnesota, Minnesota
William Stockman, State Board of Vocational Education, Minnesota
Bill Warner, Special School District 916, Minnesota
Joanne Wandrei, Minneapolis Tecnical Institute, Minnesota